Citation:

Dewailly E, Ayotte P, Lucas M, Blanchet C. Risk and benefits from consuming salmon and trout: a Canadian perspective. *Food Chem Toxicol.* 2007 Aug;45(8):1343-8.

PubMed ID: 17343969

Study Design:

Cross-sectional Study

Class:

D - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

NEUTRAL: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

- To compare concentrations of key contaminants and the essential nutrients omega-3 fatty acids between farmed and wild salmon and trout
- To balance risks and benefits from regularly consuming these species

Inclusion Criteria:

- Samples of farmed and wild Atlantic salmon and Rainbow trout

Exclusion Criteria:

- None specified

Description of Study Protocol:

Selection of study samples:

- Farmed samples obtained from supermarkets located in municipalities of the Province of Quebec, Canada [*Note: 60-85% of Atlantic salmon fillets sold in Quebec markets originates from Chilean farms, with balance from Canadian farms; 87% of farmed salmon fillets imported in the US in 2005 originates from Chile*]
- Wild samples obtained from fishermen of the Gaspe Peninsula and from various Canadian agencies

Design: Cross-sectional study

Blinding used (if applicable): not applicable

Intervention (if applicable): not applicable

Statistical Analysis

- Comparison of concentrations of contaminants and n-3 polyunsaturated fatty acids (PUFA) between market (farmed) and wild fish: Wilcoxon rank-sum test
- A concentration equal to half the detection limit was assumed for samples with concentrations below the limit of detection of the analytical method

Data Collection Summary:

Timing of Measurements

One-time measurement of contaminants and n-3 PUFA.

Dependent Variables

- Concentration of mercury: cold vapor atomic absorption
- Polychlorinated bi-phenyl (PCB) congeners (n=44): capillary column gas chromatography
- Polychlorinated dioxins/furans (PCDD/Fs) (n=17):capillary column gas chromatography
    - total toxic equivalent (TEQ) concentration: concentrations of the individual compounds multiplied by their respective toxic equivalency factor (relative to 2,3,7,9-tetrachlorodibenzo-p-dioxin), then added together
- Total lipid and fatty acid content of fish
    - total lipids measured gravimetrically
    - fatty acid composition : gas chromatography of the methyl ester derivatives

Independent Variables

- Wild versus farmed salmon and Rainbow trout
- Dietary intake of mercury, PCBs and PCDD/Fs

Control Variables

Description of Actual Data Sample:

Initial N:

- Atlantic salmon:
    - 46 farmed from 30 supermarkets located in 20 municipalities
    - 10 wild samples
- Rainbow trout:
    - 37 farmed samples from 27 supermarkets located in 16 municipalities
    - 10 wild samples

Attrition (final N): as above

Age: not applicable

Ethnicity: as above

Other relevant demographics

Anthropometrics

Location: Province of Quebec, Canada

Summary of Results:

Key Findings

- While differences were observed between market (farmed) and wild fish with regard to the concentrations of mercury and polychlorinated biphenyls, overall the concentrations of contaminants were low, such that the regular consumption of these fish would not cause tolerable daily intakes to be exceeded

Concentrations of contaminants

- Concentrations of total mercury in fillets of farmed salmon were about 3-fold lower than wild salmon ($P < 0.05$)
- PCDD/F concentrations appeared lower in farmed salmon compared to wild salmon, but N.S
- Mean total PCB concentration in farmed salmon was approximately 2-fold higher than wild salmon ($P < 0.05$)
- No differences observed between farmed and wild Rainbow trout

Concentrations of total lipids and fatty acids

- No differences in lipid content and fatty acid composition between farmed and wild Atlantic salmon
- In farmed Rainbow trout, there were higher concentrations in farmed verses wild fillets ($P < 0.05$) of total lipids (5.9-fold higher) and EPA+DHA (3.2-fold higher)

Assessment of risk and benefits (farmed salmon used for assessment) (See table)

- Recommendation for EPA+DHA intake of 500mg/day could be met by eating approximately two 180 gram portions of farmed salmon or trout/week
    - Mercury exposure at this intake:
        - current mean dietary exposure to mercury in women of reproductive age (20-39 years) = 0.019 ug/kg Body Weight (BW)/day
    - a 60 kg female consuming two farmed salmon meals/week would consume 0.015/ug/kg BW/day
    - added to the mean current intake, this would amount to 17% of the most restrictive total daily intake (TDI) for methyl mercury for this group of 0.2 ug/kg BW/day.
    - PCB exposure
        - average daily intake of PCBs for Canadian women of reproductive age = 0.002 ug/kg BW/day
        - a 60 kg woman consuming two farmed salmon meals/week would consume an addition 0.012 ug/kg/ BW/day)
        - added to the average intake, this would amount to 11% of the TDI of 0.13 ug/kg/ BW/day
    - PCDD/Fs exposure
        - average dietary intake of adults = 0.62 pg TEQ/kg BW/day
        - intake resulting from eating two farmed salmon meals per week: 0.07 pg/kg BW/day,
        - this would amount to 69% of the lower limit of the range of TDI proposed by

WHO (1 pg/TEQ/kg BW day)

- TEQ
  - total TEQ intake from eating two salmon meals/week: 0.28 pg/kg BW/day
  - based on average daily dioxin-like PCB intake from other sources of 0.002 ug/kg/day), TEQ estimated to be 0.02 pg/kg BW/day
  - average TEQ would be 0.64 pg /kg BW/day
  - when both dioxin-like PCBs and PCDD/Fs are considered, the average total dioxin-like compound exposure corresponding to two farmed salmon meals/week = 0.92 TEQ/kg BW/day or 92% of the lowest TDI

Author Conclusion:

In as much as fish with relatively low contaminant burden, such as that observed in the present study, continues to be available in North American markets, eating two salmon or trout meals per week can be recommended to increase EPA and DHA intake towards optimal values, without worrying about the putative health risks.

Reviewer Comments:

Small number of samples; only 10 samples of wild fishes studied.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes

1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	???
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	N/A
2.4.	Were the subjects/patients a representative sample of the relevant population?	???
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A

5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	N/A
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes

7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	???
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	???
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	N/A
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes